Chapter 4
SURF ZONE HYDRODYNAMICS

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Surf Zone Hydrodynamics

II-4-1. Introduction

a. Waves approaching the coast increase in steepness as water depth decreases. When the wave steepness reaches a limiting value, the wave breaks, dissipating energy and inducing nearshore currents and an increase in mean water level. Waves break in a water depth approximately equal to the wave height. The *surf zone* is the region extending from the seaward boundary of wave breaking to the limit of wave uprush. Within the surf zone, wave breaking is the dominant hydrodynamic process.

b. The purpose of this chapter is to describe shallow-water wave breaking and associated hydrodynamic processes of wave setup and setdown, wave runup, and nearshore currents. The surf zone is the most dynamic coastal region with sediment transport and bathymetry change driven by breaking waves and nearshore currents. Surf zone wave transformation, water level, and nearshore currents must be calculated to estimate potential storm damage (flooding and wave damage), calculate shoreline evolution and cross-shore beach profile change, and design coastal structures (jetties, groins, seawalls) and beach fills.

II-4-2. Surf Zone Waves

The previous chapter described the transformation of waves from deep to shallow depths (including refraction, shoaling, and diffraction), up to wave breaking. This section covers incipient wave breaking and the transformation of wave height through the surf zone.

a. Incipient wave breaking. As a wave approaches a beach, its length L decreases and its height H may increase, causing the wave steepness H/L to increase. Waves break as they reach a limiting steepness, which is a function of the relative depth d/L and the beach slope $\tan\beta$. Wave breaking parameters, both qualitative and quantitative, are needed in a wide variety of coastal engineering applications.

(1) Breaker type.

(a) *Breaker type* refers to the form of the wave at breaking. Wave breaking may be classified in four types (Galvin 1968): as spilling, plunging, collapsing, and surging (Figure II-4-1). In *spilling breakers*, the wave crest becomes unstable and cascades down the shoreward face of the wave producing a foamy water surface. In *plunging breakers*, the crest curls over the shoreward face of the wave and falls into the base of the wave, resulting in a high splash. In *collapsing breakers* the crest remains unbroken while the lower part of the shoreward face steepens and then falls, producing an irregular turbulent water surface. In *surging breakers*, the crest remains unbroken and the front face of the wave advances up the beach with minor breaking.

(b) Breaker type may be correlated to the surf similarity parameter ξ_o, defined as

$$\xi_o = \tan\beta \left(\frac{H_o}{L_o} \right)^{-\frac{1}{2}} \qquad \text{(II-4-1)}$$

where the subscript o denotes the deepwater condition (Galvin 1968, Battjes 1974). On a uniformly sloping beach, breaker type is estimated by